

# SOME ZOOLOGICAL PROBLEMS ASSOCIATED WITH HIGH ALTITUDES OF THE HIMALAYAS<sup>1</sup>

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*(With a map)*

## INTRODUCTION

Any form of life, at a given time, represents the product of the interaction of its environment and heredity. The environment has indeed a key-rôle in the process of evolution. A correct appraisal of the mechanism of evolution cannot, therefore, be made without a thorough study of the environmental factors through which life passed and is passing, and their effects on the living things.

For the purpose of biological studies, the earth is divided into a number of ecological zones, each of which has its own distinctive characteristics. The zones have, moreover, similarities with one another. Though for various reasons one cannot delimit such zones into watertight compartments, yet it is perhaps possible to define certain geographic areas possessing certain specific attributes and supporting a certain type of life. High altitude is one such ecological zone, and its environmental factors differ substantially from those of lower elevations.

## DEFINITION OF HIGH ALTITUDES OF THE HIMALAYAS

From the point of view of physical geography it is possible to define a particular elevation limit above which everything may be termed as 'high altitude', but as a biologic environment the definition of high altitude should not depend entirely upon the elevation of land above mean sea level for reasons set forth below.

The Joint Commission on High Altitude Research Stations in its report (see Korff, 1954) has defined 'high altitude' as regions 'in excess of about 7,500 ft., or about 2,000 meters.' Unfortunately, nowhere does the report give any basis for this definition. This report reveals that most of the high altitude research stations listed in it are solely or mainly for the study of the physical sciences; that the few stations where biological investigations are or can be conducted are situated between 10,000 and 14,000 ft., the only three exceptions being established at fairly northerly latitudes ( $34^{\circ}\text{N}$   $47^{\circ} 19'\text{N}$ ); and that the only station of the Himalayas viz. Gulmarg Research Observatory, Kashmir, is located at about 9,000 ft. at  $34^{\circ}\text{N}$ . These would tend to show that factors for researches in the physical sciences have been mainly considered in adopting the above definition by the Commission. Besides, many people, including some biologists, have a rather vague conception of what constitutes the high altitude zone for biological purposes, and

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different altitudinal figures ranging between 5,000 and 10,000 ft. have often been quoted as the lowest limit of 'high altitude'. From my personal acquaintance with animals at high altitudes in Sikkim<sup>1</sup>, and in the Mount Everest area of Nepal as a member of the *Daily Mail* Himalayan Expedition 1954 (Biswas and Khajuria, 1954; Izzard, 1955; Biswas, 1955), I find, however, that the Commission's definition seems hardly tenable in so far as the Himalayas are concerned. And, I am sure, biologists with first-hand knowledge of animals and plants of the high Himalayas and the environment in which they live will agree with me.

The 'high altitude zone' as a biotic environment possesses certain attributes which have a definite and understandable effect on the life that exists there. The most obvious physical factors of high altitudes are reduced atmospheric pressure, low temperature, and high light intensity. There is no doubt that they have an important bearing on the physiological processes of organisms living there.

While the fauna of high altitudes of India is only perfunctorily known, the floristic studies demonstrate interesting gradations in the forest types as we go above the temperate coniferous zone. It has been seen that the 'Alpine Fir-Birch Forest' zone as defined by Champion (1936, p. 269) is the uppermost limit in the Himalayan region, beyond which there is a sharp transition of flora with rhododendron shrubs predominating. This transition obviously corresponds to the different biotic environments met with in the two zones. Champion's 'Alpine Fir-Birch Forest' zone may, therefore, be taken as the lowest limit of high altitude as a biotic environment. The limit of the alpine fir-birch zone varies from west to east, being about 3,000 meters (*ca.* 9,840 ft.) in the western Himalaya, and 3,800 m. (*ca.* 12,500 ft.) in the eastern.

It is apparent that the physical elevation alone does not give rise to high altitude conditions. Furthermore, it is apparent that the limit differs widely according to the local conditions of geographical position and direction of the mountain ranges, moisture-content of the air, velocity of the wind, ice formation, avalanches, landslides, solifluction, composition of soil, etc. (Griggs, 1946). Thus, in the Rocky Mountains, Washington, the tree-line is about 3,300 m. (*ca.* 10,800 ft.), while on different slopes of Mount Washington, New Hampshire, it varies between 1,200 and 1,740 m. (*ca.* 3,900 and 5,700 ft.), and at Bay of Islands, Newfoundland, it is only 300 m. or about 980 ft. (Clarke, 1954)! Likewise, there is indeed a sharp difference in the altitudinal figures for tree-lines on the northern and southern faces of the Himalayas.

### ZOOLOGICAL PROBLEMS

In an area as interesting as high altitudes of the Himalayas, the animal and plant lives should also be highly interesting, since they tend to pose a number of important biological problems of a fundamental nature. But, unfortunately, we know so little about the animals

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<sup>1</sup> See *JBNHS*, 51: 530 (1953).

of high altitudes that we are unable to make any headway. Not very long ago the ounce or snow leopard (*Panthera uncia*) used to roam about the high Himalayas in fair numbers, but it is rather scarce now—so much so that it has been included in the list of protected Indian animals (prohibited for shooting and export). It follows, therefore, that proper measures ought to be taken soon to prevent its extinction. But, so little is known about the ounce — its status, its life, its habits and habitats — that no effective measures, however genuine, seem possible immediately for its preservation. India has a substantial trade in fur of high altitude animals, but the possibilities of expanding the trade by scientifically rearing these animals cannot be explored, because nothing very much is known about them.

We are better acquainted with game mammals and game birds of the high altitudes because of their value as sport, but nothing is known about the adaptive adjustments that have enabled them to flourish under such highly specialized conditions.

It would then appear that there are a number of zoological problems associated with high altitudes of the Himalayas, which require our urgent attention. The more important ones are briefly discussed below. It is, however, necessary to state that most of these problems are so interlinked that they are grouped together under certain general captions.

#### FAUNAL STUDIES

Faunal studies are the first prerequisite for any type of detailed zoological researches. Although a number of Expeditions (mostly political!) made collections of animals at high altitude areas of the Himalayas, no systematic faunistic survey has as yet been conducted there. A thorough survey of animal life of the high altitude area demands, therefore, our first and foremost attention. Faunal studies may be conducted roughly along the following lines:

**S y s t e m a t i c s a n d Z o o g e o g r a p h y:** Studies on systematics of animals and zoogeography should provide faunal lists of the various groups of animals, a knowledge of their horizontal and vertical distribution, the proportion of palaearctic and oriental elements, and other relevant topics.

**E c o l o g y:** A study of the physico-chemical and biotic elements of environments and their effects on animal life is also in demand.

These investigations are likely to be of far-reaching consequence in understanding the process of organic evolution. They may also throw light upon many palaeogeographic problems, so little understood at present, and on the spread of pests and diseases.

#### BIONOMICS OF ANIMALS

High altitudes present certain specific environmental conditions that require special adaptations. Limited amount of vegetation, extreme temperature condition, strong wind, freakish weather, low oxygen<sup>2</sup> and moisture-content of the air would normally make it difficult for

animal life to survive and flourish under such conditions. In spite of this, it is amazing that the Himalayas support a great variety of fauna in the higher domains. How these animals live, breed and flourish there is indeed one of the most fascinating problems.

Studies of the life-histories of different animals — their modes of reproduction, various stages of development and growth — all involve observations both in the field and in the laboratory throughout the year. Furthermore, various physiological processes, such as respiration, circulation, digestion and metabolism, and food and breeding habits, call for extensive studies, experimental and otherwise.

Severe weather conditions of high altitudes are either resisted or escaped by animals through migration to more favourable areas, or they induce a spell of dormancy. These phenomena may be studied under the following heads:

**Hibernation:** This state of dormancy is so far known to be brought about by gradually decreasing temperature, inadequacy of heat regulating mechanisms, shortage of food, dryness of food, concentration of carbon dioxide in the hibernacula, accumulation of fat, glandular disturbances, etc. Though some work on the hibernation of some animals has been done in Europe and America, it is not known how far the factors mentioned above induce hibernation under the prevalent Himalayan conditions.

**Aestivation:** This is another state of dormancy, but is brought about by drought instead of by low temperature. With the increase in altitude, there is an increase in the rate of evaporation, thereby causing loss of water-content leading to aestivation. The question of aestivation has, therefore, a direct bearing on the water-relation of animals.

**Overwintering:** This involves passing through severe winter conditions. So far as is known, animals resist the cold of winter by the development of protective covering, by decreasing physical and metabolic activities, by developing cold-hardiness, or by a combination of some or all of these measures. Although the phenomenon of overwintering has been known in insects as well as in vertebrates occurring in other parts of the world, it is as yet unknown for the Himalayan animals.

**Migration:** The escape from severe weather conditions involves an orderly movement of animals. In some groups, such as birds, this takes place on a geographic scale, that is, they migrate from one country, even from one continent, to another. In certain other groups, such as insects, geographic migration is rather rare. In typical cases, it may be noted, the migrated animals return to their original homes when conditions become favourable.

#### PARASITOLOGICAL STUDIES

The incidence of parasitism among animals dwelling at high altitudes is very little known. There is a large scope for investigation



of ectoparasites and endoparasites of animals living in this zone, especially of the warm-blooded vertebrates. Studies on the seasonal fluctuation in the frequency of parasitic infection, though known for some of the parasites at lower altitudes, have not been conducted for high altitude areas. The usefulness of such studies in relation to human and animal diseases is obvious and need not be underlined.

#### STUDY OF VARIATIONS

It is a well-known fact that no two individuals of the same species look exactly alike. This is due to the biological fact of variation. The study of variations is one of the most important aspects of evolutionary biology, and is one of the main pivots on which the process of organic evolution, as understood today, turns.

Variations are of two types, phenotypic and genotypic, the essential difference between the two being that the latter is heritable though not always perceptible, while the former is detectable but may not be heritable.

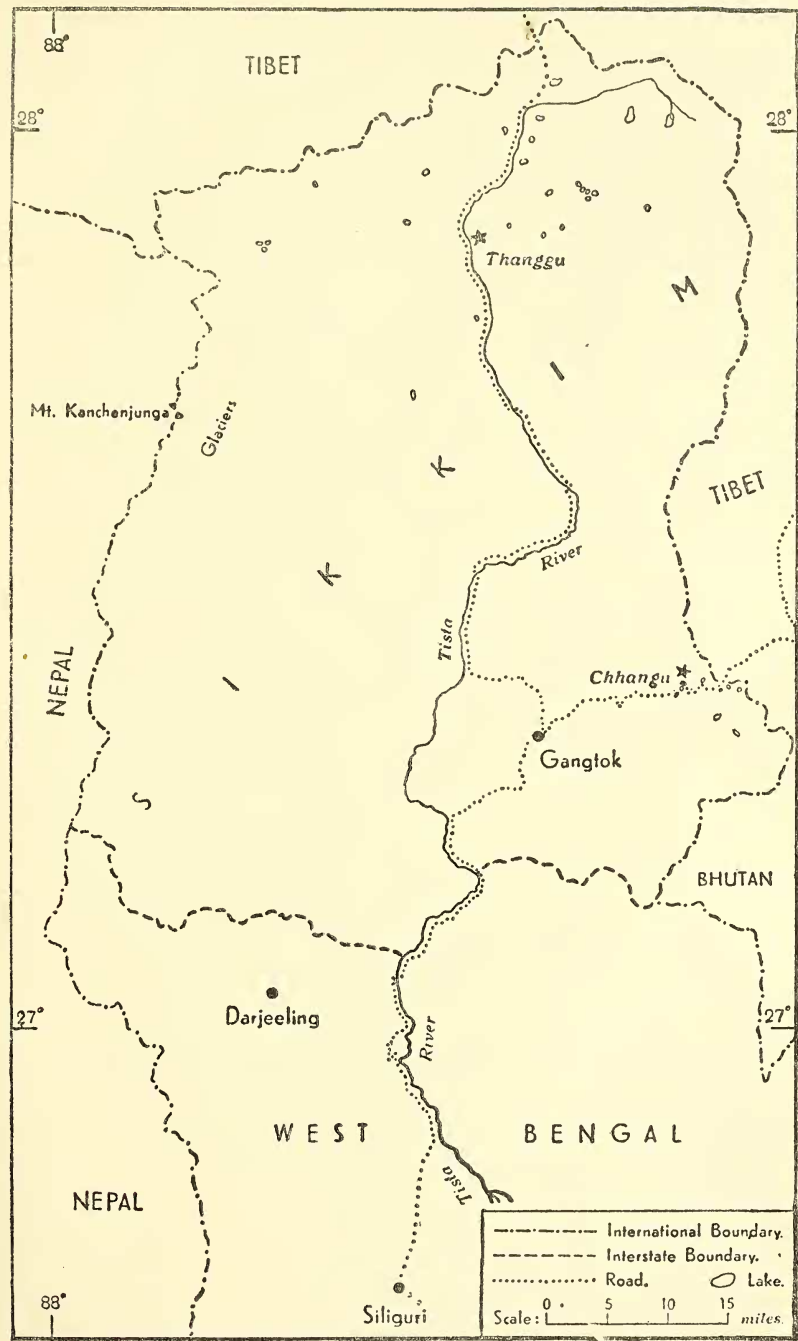
Low temperature is known to bring about certain interesting variations in animals, two of which are mentioned below :

**Cyclomorphism:** This is the phenomenon of phenotypic changes in structure brought about by change in the season. Such structural changes are usually transitory and reversible, and the animals regain their original structure on the return of normal season. The phenomenon has been observed in certain crustaceans, and is believed to be caused largely by low temperature. It is, however, likely that some other factors, unknown at present, may have contributory rôles in producing cyclomorphism.

**Jordan's Rule:** This is the relationship between the temperature and the number of vertebrae in closely related species of fishes. Fishes of colder waters tend to have more vertebrae than those occurring in warmer waters. This phenomenon is an instance of genotypic variation. Although verified for different latitudes, one does not know to what extent Jordan's Rule is applicable to fishes residing in higher altitudes where water is sufficiently cold. This principle may be of use to fishery biologists in ascertaining the origin of populations among the species of fish that exhibit this phenomenon. It is also worthwhile examining how far this phenomenon is applicable to other groups of vertebrates.

#### CONCLUDING REMARKS

It will have been noted from what is detailed above that the high altitudes of the Himalayas have received less than their merited share of attention, although they are pregnant with possibilities for some outstanding zoological researches of a fundamental nature. There is no gainsaying the fact that the bearing of such researches on man is far reaching. Studies of the adaptation of animals to extremely low temperature, low atmospheric pressure, low oxygen-content of the atmosphere, limited food supply (qualitative and quantitative), high



Map 1.—Part of the eastern Himalayas showing the suggested locations\* of the High Altitude Biological Research Stations.

